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(71) Applicant
National Research Development Corporation, (United Kingdom), 101 Newington Causeway, London, SE1 6BU
(72) Inventors
Barrie Bancroft, George King Greenough, John Philip Hodges, David George Whitelaw
(74) Agent and/or address for service
J. S. Spaight, Patent Department, National Research Development Corporation, 101 Newington Causeway, London, SW1 6BU

(54) **Performance monitor for respirator helmets**

(57) In order to monitor the performance of a helmet respirator (1) Fig. 1 (not shown) equipped with a visor 2 and supplied with air via a fan (3) a float-type pressure gauge 4 is mounted within view of the helmet wearer. Leakage of air from within the visor to the atmosphere via the gauge when the pressure within the visor is above a predetermined minimum is arranged to maintain a float 8 within the gauge in a substantially stable position therewithin. At lesser pressures the float falls to give an immediate visual indication to the wearer that the degree of protection otherwise afforded by the respirator has been reduced.

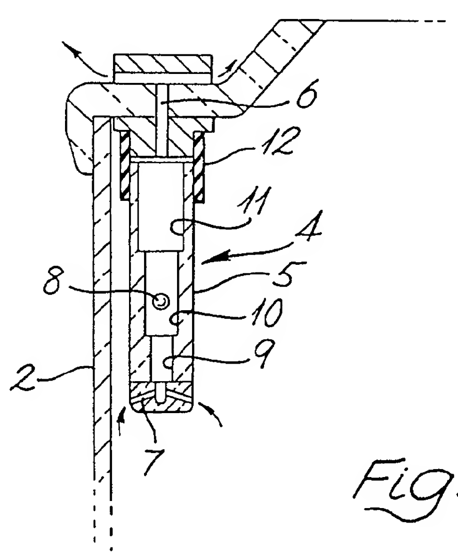

Fig. 2

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The drawing originally filed was informal and the print here reproduced is taken from a later filed formal copy.
The claims were filed later than the filing date within the period prescribed by Rule 25(1) of the Patents Rules 1982.

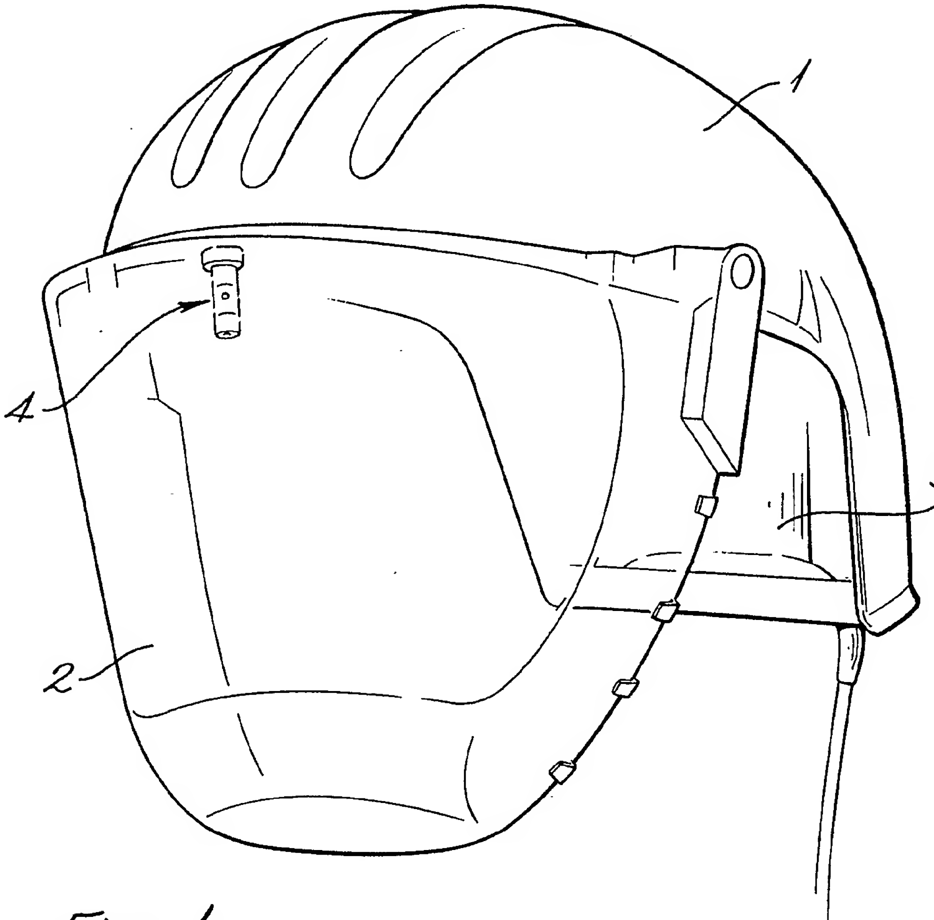

Fig. 1

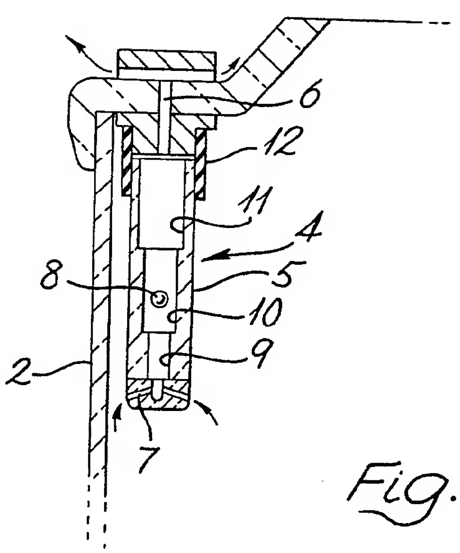

Fig. 2

SPECIFICATION

Performance monitor for respirator helmets

This invention relates to helmet respirators such as for example described in British Specifications Nos. 1,426,432 and 1,495,020. In such respirators an air flow is established by a battery driven fan mounted within a rear portion of the helmet, the air being filtered either or both upstream and downstream of the fan. An airflow passage is established over the head of the user and down past his face, the helmet being provided with a transparent visor between which and the wearer's face a seal may be provided.

No valves are however provided in the airflow system and reliance is placed on positive pressure within the helmet to limit the ingress of unfiltered air and on the provision of a relatively large flow of filtered air to dilute any unfiltered air that does enter the breathing zone of the wearer. As the filters become clogged or as the voltage of the fan battery falls the airflow through and the pressure within the helmet will fall, thus reducing the protection otherwise afforded.

A previous proposal to identify falling efficiency of the system from the above mentioned causes involved the use of an airflow indicator plate which was a perforated plate designed to be sucked against the fan air intake and of such a weight and flow resistance that it could just be supported at a predetermined flow rate, e.g. 160 litres per minute. At lower flows the plate would fall away thus giving an indication of inadequate airflow. Necessarily however this indication could only readily be obtained by checking a helmet at the beginning of a period of wear, or at best only at intermittent intervals. Even the fact that it required the wearer to carry out a specific test of the airflow function constituted a drawback in that the need to carry out a check might be neglected. When helmet respirators are used for protection against dusts such as asbestos, even a short exposure to which can be harmful, it is desirable to have means continuously to monitor the functioning of the airflow system.

It has been demonstrated that for any value of external ventilation velocity there is a "threshold" level of static pressure within the visor of a helmet respirator below which the ingress of unfiltered air rises sharply. One way therefore of monitoring the performance of such a helmet is to monitor the static pressure within the visor. However the pressure is not the only criterion of adequate functioning since a minimum level of airflow is required regardless of pressure to sweep out exhaled carbon dioxide and also to avoid misting of the visor. In general terms however visor flow and pressure are related to the area of the exhaust orifice and for a given design of helmet it should be possible to monitor either pressure or flow; both alternatives have advantages and disadvantages.

Measurements on helmet respirators have shown that the airflow velocity and static pressure can vary throughout the visor area, particularly near the wearer's face where the velocity may be appreciably reduced and the pressure may be as much as twice that at a point midway between the wearer's face and the visor. The flow velocity and pressure at any point may be expected to vary, at least to some extent, with the wearer's physiognomy and with the orientation of the helmet on the wearer's head. Thus it may be difficult to establish a single value of visor flow or pressure, or a single point of measurement that is realistic for all wearers. The variation in static pressure is much reduced at higher static pressures, however, such as would be necessary in a helmet providing a high protection factor.

Since the airflow delivered by the fan will be reduced if the filters are clogged or if the battery voltage is reduced, monitoring the fan delivery might seem to be a solution; however the fan delivery will also be affected by faulty sealing in that a faulty or badly fitting seal around the wearer's face would result in an increased airflow giving an apparently satisfactory indication whereas, in fact, the protection could be less than satisfactory. This would be particularly true in a helmet designed for a high protection factor since such a helmet would be very much dependent on the effectiveness of the seals. Since the extra cost and complication of a monitor is likely to be justified only with a helmet offering a high protection factor, monitoring the fan delivery would seem unlikely to be satisfactory. Consideration of the above factors has led to the conclusion that monitoring the internal pressure within the helmet is likely to be the most satisfactory technique, provided that a region can be established where the pressure is not unduly affected by the individual characteristics of the wearer, and provided that a minimum value of airflow can be achieved regardless of pressure.

A common technique for monitoring pressure is to utilise the deformation of a sensitive capsule, e.g. a Bourdon tube as in a pressure gauge. For small pressure, the deformation of a thin diaphragm may be measured, e.g. by an electrical strain gauge or by a change in electrical capacitance of an adjoining air gap. Both these latter techniques have the drawback that they require sophisticated circuitry and are likely to be costly.

According to this invention therefore it is proposed to utilise a simple float type pressure gauge mounted within the visor of a helmet respirator to give an immediate visual indication when the pressure within the visor falls below a predetermined value.

The invention is further described below with reference to the accompanying drawing, in which:—

Figure 1 is a perspective view of a helmet respirator fitted with a monitor in accordance with the invention, and

Figure 2 is a sectional elevation on an enlarged scale of the monitor.

Referring to the drawing, a helmet respirator comprises a helmet portion 1 to which a visor 2 is fitted. A fan is mounted in the rear part 3 of the helmet to create an airflow within the helmet over the head of the wearer and down between the wearer's face and the visor. An airflow monitor 4 in accordance with the invention comprises a tube 5 of transparent material vertically mounted within the upper part of the visor, conveniently at a central location, so as to be readily visible by the wearer, although possibly not in sharp focus. The upper end of the tube is fixed to the visor frame and a small hole 6 passes through the frame so as to connect the bore of the tube to atmospheric pressure. Preferably as shown the tube 5 is connected to a mounting block on the visor frame by a flexible sleeve 12. In case of impact the monitor 4 can then flex relative to the visor so as to avoid any hazard of the monitor being driven into the wearer. The lower end of the tube is also provided with one or more small holes 7 so as to connect its bore to pressure within the visor. The latter is greater than atmospheric pressure and hence in use a small leakage flow passes through the tube. A small lightweight sphere 8 conveniently of plastics is located within the tube. The dimensions of the holes 6 and 7, the bore of the tube 5 and the weight of the sphere are selected such that the sphere tends to rise as the pressure within the visor exceeds a predetermined level, and to fall at a pressure below that level. To stabilise movement of the sphere or ball 8 within the tube the lower portion 9 of the tube is provided with a smaller bore than the middle portion 10 and the upper portion 11 is of still larger diameter.

The dimensions are chosen such that at pressures below the chosen threshold the ball 8 will fall into the lower portion 9 of the tube 5 whilst at higher pressures it will rise to the top of the middle portion 10 and remain in a substantially stable position at the lower entrance to the upper portion 11 of the tube.

Hole 7 may be offset so as to cause the air to swirl within the tube 5 and impart rotation to the sphere 8. This reduces any tendency of the sphere to cling to the tube wall due to electrostatic attraction, and also makes the sphere more visible, particularly if part of its surface is painted in a contrasting colour.

Typical dimensions are:—

Ball 8	diameter—3.43 mm weight 0.856 mg
Bore of tube portion 9	4.0 mm diameter
10	5.0 mm diameter
11	6.0 mm diameter
Hole 6	3.0 mm diameter
Hole 7 three holes	1.5 mm diameter
Visor threshold pressure	10 Pa.

To facilitate moulding, the three portions of the tube 5 may be slightly tapered, provided the taper is discontinuous so as to form a threshold between each section. Tapering of the relevant tube portion can also provide a graded response of the sphere. It is not however thought desirable to render the sphere too responsive so that for example it responded to pressure changes caused by the wearer's breathing.

The lighter is the sphere, the more sensitive is the monitor and the lower is the amount of air that is lost through the monitor instead of passing down the visor. Hollow glass or hollow plastic spheres may be suitable but expanded polystyrene spheres are suitable and readily available. As supplied however (e.g. for thermal insulation) they tend to be of random size, weight and density, and may be of such a low density as to be excessively sensitive to electrostatic forces. The density may be increased by heating which causes the spheres to shrink in a controllable manner. Thus the spheres may be heated in an oven at for example 120—130°C until they pass through holes of appropriate diameter, for example 3.6 to 3.75 mm, formed in a gauge plate. Conveniently the spheres may be drawn through the gauge plate and removed from the oven by suction. The spheres may then be selected aerodynamically by placing them within a tapered tube through which air is passed at a controlled rate. Spheres that settle within appropriately set tolerance marks are selected for use in the monitor.

Claims (filed on 11 Nov 1983)

1. A helmet respirator incorporating a visor, provided with a float-type pressure gauge positioned to be in the view of the wearer and arranged to give an immediate visual indication when the pressure within the visor falls below a predetermined value.

2. A helmet respirator as claimed in Claim 1 in which the pressure gauge comprises a substantially vertically arranged transparent tube mounted within the visor and through which air or other gas supplied to the respirator is arranged to leak to atmosphere, the tube being formed with a bore having lower, middle and upper portions of successively increasing diameter, the dimensions of the said tube portions and of the float together with the density of the latter being chosen such that at pressures below the predetermined value the float will fall into the lower tube portion whilst at higher

pressures it will rise to a substantially stable position adjacent the junction of the middle and upper tube portions.

3. A helmet respirator equipped with a float-type pressure gauge constructed, arranged and adapted to operate substantially as herein described or as illustrated in the accompanying drawing.

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